THE COMET

Air-o-Trainer

TRADE MARK

BASIC PRINCIPLES of AIRPLANE CONTROL

A PRACTICAL GUIDE FOR STUDY
IN CONJUNCTION WITH
THE COMET AIR-O-TRAINER

PRICE 10c

ACKNOWLEDGMENT

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"AIR CASTLES"

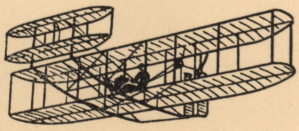
"America's future? It is in the air. Not only will air-power guarantee our victory in the present war-effort, but it will be the greatest single influence in our post-war world. Aviation is making great strides, and it is up to our generation to keep step with it."

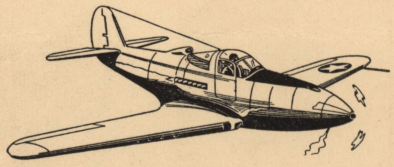
"AIR CASTLES" photo courtesy Model Industry Association

DEVELOPMENT OF AIRPLANE CONTROLS

In the early development of the airplane the method of controlling it in the air was one of the most difficult problems to be worked out. Many different ideas were tried with varying success before the control system, as used on present day aircraft, was finally developed.

The gliders built by Lilienthal were controlled by shifting the pilot's weight, all the surfaces being in fixed position. This system, aside from being very tiring for the pilot, had the added disadvantage of a delayed action which required the pilot to think far in advance of his maneuvers. The method of control was not very satisfactory.

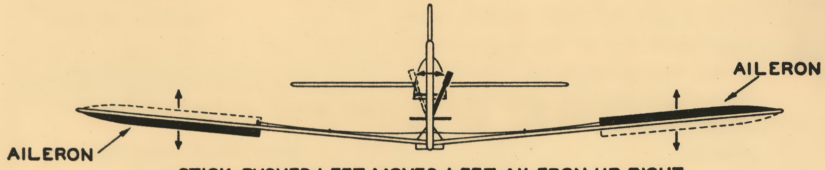




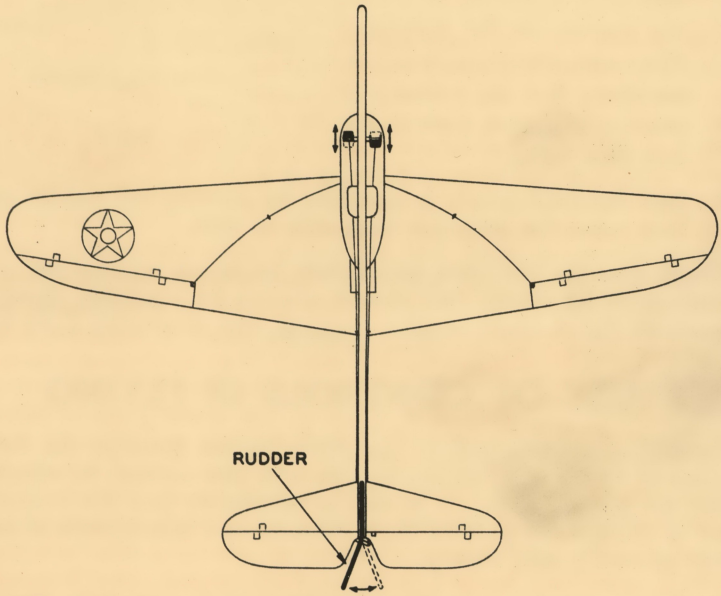
The Wright Brothers, who had the benefit of wind tunnel experiments, used a sounder arrangement. They employed a horizontal, movable surface forward of the wing for guiding up or down and warped the wingtips for banking and turning. Later refinements by Bleriot, Glenn Martin, Glenn Curtiss and others brought the horizontal control surface around in back and added a vertical fin and hinged rudder for turning. Instead of warping the wingtips for banking, auxiliary hinged surfaces were added—first between the wings at the tips, and finally ailerons were installed directly at the trailing edges of the wings. This arrangement is used on most of the airplanes in service today.

The control surfaces are actuated by a control stick or wheel and rudder pedals. These surfaces change the plane's course due to the exertion of air pressure against them when they are moved out of line of the fixed surfaces. (Fig. 2).

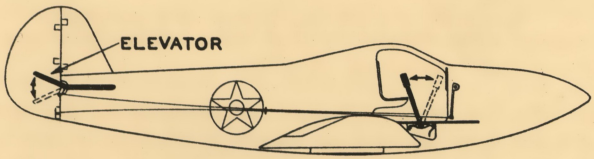
The Air-o-Trainer was designed to demonstrate the action of controls and how they should be used in various flying maneuvers. Its controls are operated in the same manner as in full scale aircraft. The only way to learn flying is to actually fly a plane under the guidance of an instructor. By working the controls of the Air-o-Trainer, however, you have a graphic demonstration of what happens when the controls are moved.



STICK PUSHED LEFT MOVES LEFT AILERON UP, RIGHT AILERON DOWN, BANKING AIRPLANE TO LEFT.



LEFT RUDDER PEDAL PUSHED FORWARD MOVES RUDDER TO LEFT, TURNING PLANE TO LEFT. RIGHT PEDAL FORWARD FOR RIGHT TURN.



STICK PULLED BACK MOVES ELEVATOR UP MAKING PLANE CLIMB. STICK PUSHED FORWARD MAKES PLANE DIVE.

Fig. 1

The three main control surfaces on an airplane are:

1. *THE ELEVATORS* which are operated by a back-and-forward movement of the stick. This changes the upward and downward attitude of the plane.
2. *THE AILERONS* which are operated by the sideways movement of the control stick and give a rolling or banking motion to the airplane. They operate opposite to one another; that is, when one goes up the other goes down, and vice versa.

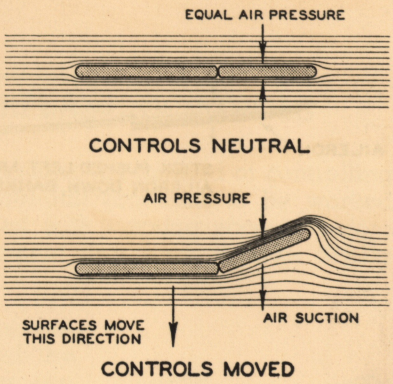


Fig. 2

3. *THE RUDDER* which is operated by moving the rudder pedals. This turns the airplane from side to side.

These controls are used separately for some maneuvers, and in coordination for others and should always be operated slowly and smoothly. Fig. 1 identifies the controls and illustrates their action.

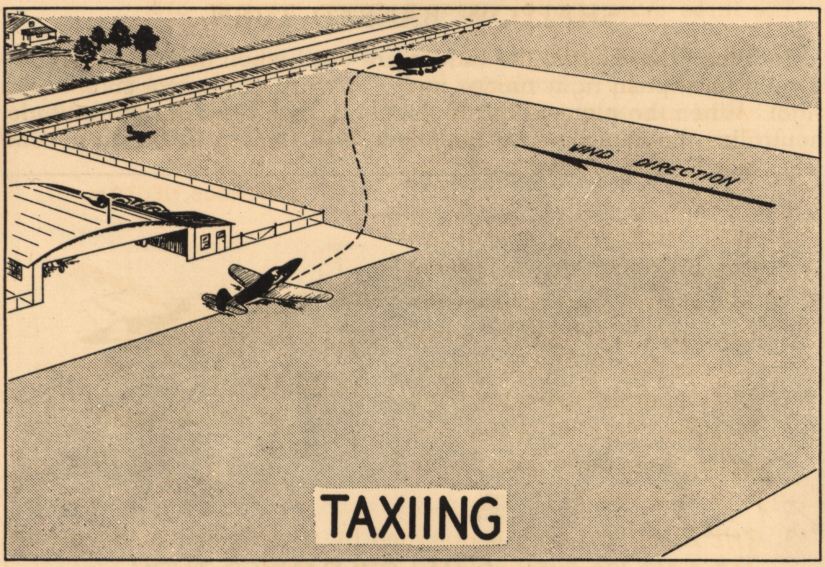
USE OF CONTROLS IN FLYING

Operating the controls of the Air-o-Trainer through the different phases of flying will familiarize you with the manner in which they affect the plane's flight. It is well to remember that the controls are used to change the plane's flight attitude and movements should be made smoothly and slowly.

Engine speed and instrument reading are important in the execution of most maneuvers; however, in this booklet we will concern ourselves basically with the movement of controls. Speed of engine and instrument readings will vary, depending on the ship flown.

PREPARATION FOR TAKE-OFF

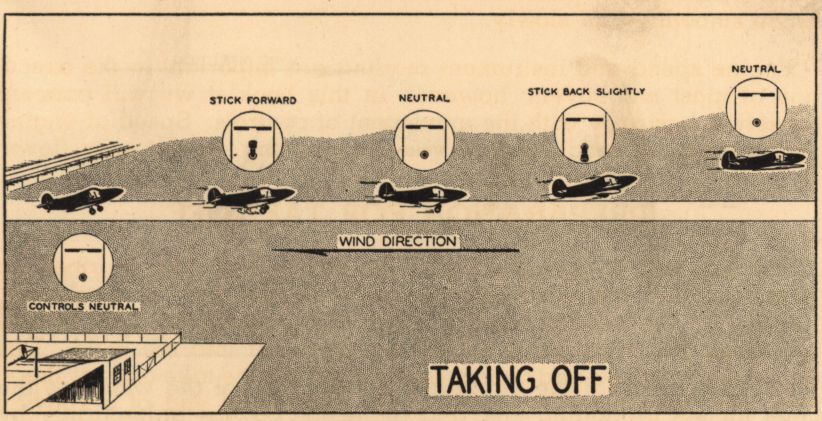
The first step in taking off after the engine has been warmed up is to ascertain the wind direction as indicated by the wind sock, usually on the hangar roof; or some other means such as smoke, tall grass, etc. The plane should be taken off into the wind. This increases air speed and consequently shortens the take-off run; therefore, the plane must be taxied to the downwind end of a runway facing into the wind. Due to the comparatively slow speed in taxiing, movement of the controls must be exaggerated to make them



effective. The control stick should be held back of neutral position to keep the tail on the ground. The rudder and brakes are used for turning the plane.

TAKING OFF

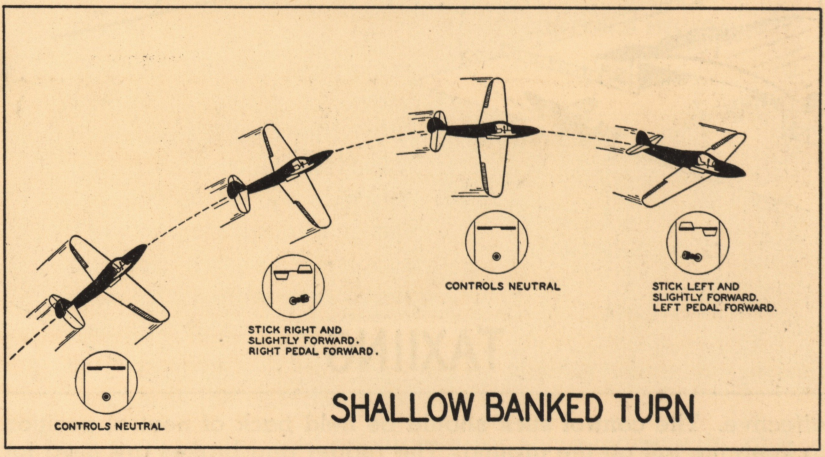
The motor is "revved" up and the stick shoved gently forward as the plane gains speed and until it is in a horizontal flight attitude. The stick is moved to neutral until the plane gains flying speed and then is pulled slowly back to raise the plane off the ground. Neutralize the controls at a climbing angle which will not cause loss of flying speed and gain a good bit of altitude. The rudder and the



ailerons are not used in taking off except to keep the plane on a straight and level course.

SHALLOW BANKED TURN

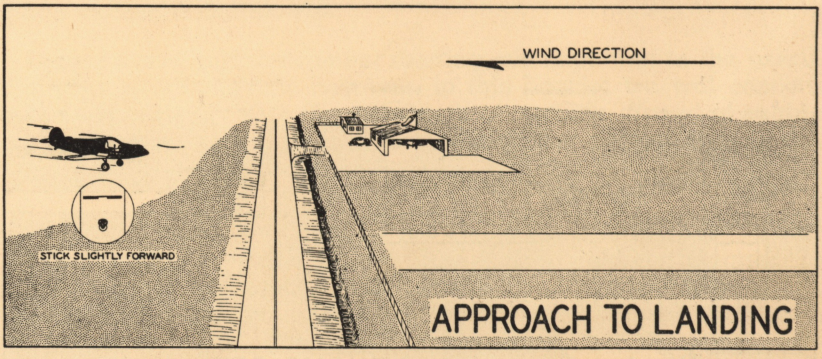
Both the ailerons and the rudder are used when turning. To make a right turn, push right rudder pedal forward and move stick to the right. When the plane is in the desired banked and turned attitude, neutralize the controls and the plane will remain in the turn. The


CONTROLS NEUTRAL
STICK RIGHT AND SLIGHTLY FORWARD. RIGHT PEDAL FORWARD.
CONTROLS NEUTRAL
STICK LEFT AND SLIGHTLY FORWARD. LEFT PEDAL FORWARD.
SHALLOW BANKED TURN

plane is brought out of the turn by reversing the controls, that is, left rudder and stick to left until in level flight on new course, then moving controls to neutral, maintaining level flight.

APPROACH TO LANDING

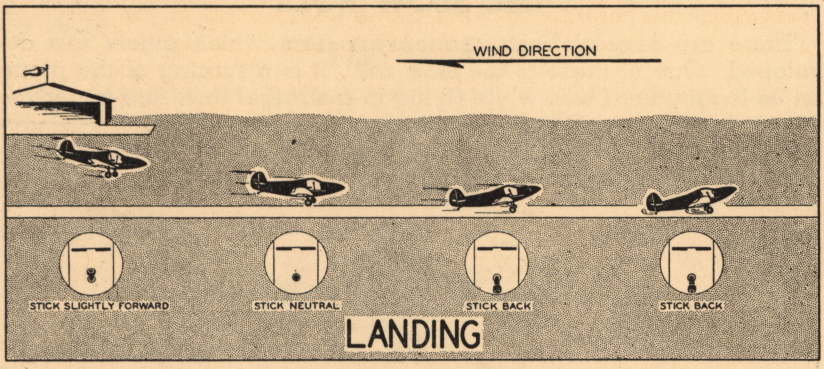
Landings should be made into the wind to shorten landing run and reduce ground speed. Part of the secret of a skillful landing lies in beginning the glide at the correct distance from the airport.



The gliding ratio of the plane and the velocity of the wind are the chief factors in judging this, and perfection can be gained only by practice. Slipping can be employed to shorten the glide, gunning the engine to lengthen it.

LANDING

On nearing the ground the control stick is gradually pulled back until the plane is leveled off a few feet above the runway. It will then slowly lose flying speed and the stick should be pulled farther

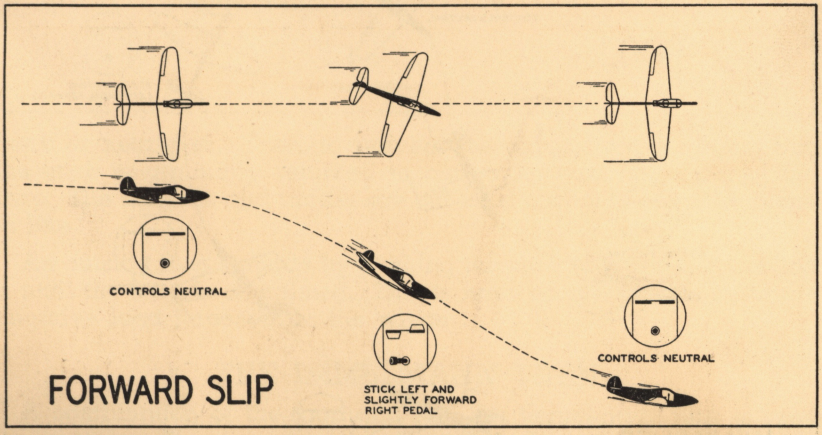


back so that the plane stays off the ground until it slows down, sinks, and lands on the wheels and tailskid. Leveling off is quite important for smooth landings. If it is done too high, the plane finally stalls and falls abruptly. If done too low, the plane flies into the ground and strains the landing gear.

AEROBATICS

Aerobatics, or stunting as it is often called, is used in all aerial exhibitions. However, it has its chief effectiveness in warfare, where the pilot's life depends on his outmaneuvering the adversary.

THE FORWARD SLIP

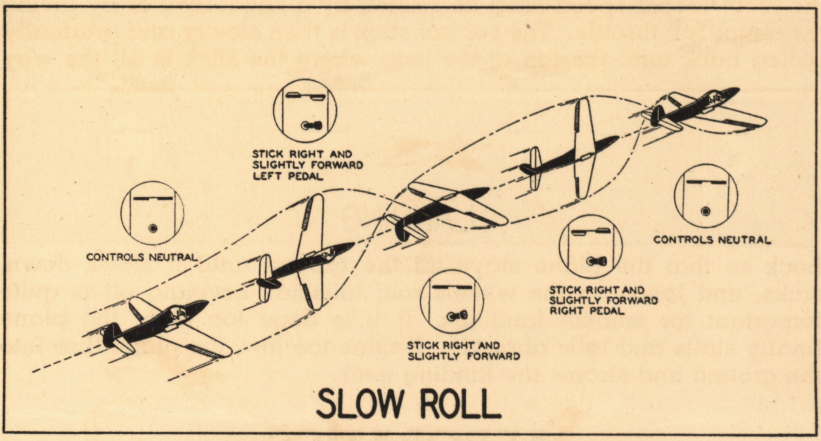


Sometimes when landing it is desired to lose altitude quickly without changing forward direction or increasing flying speed. This is

accomplished by the forward slip. Push one of the rudder pedals partway forward, simultaneously moving the control stick a little in the opposite direction. To come out of the slip neutralize all controls.

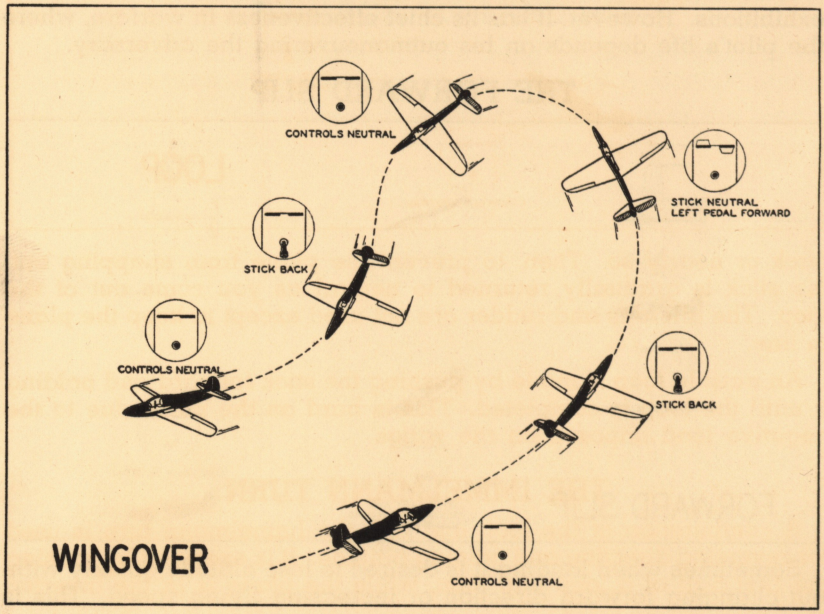
THE SLOW ROLL

There are several basic maneuvers from which others are developed. One of these is the slow roll. It is a turning of the plane on its longitudinal axis while flying in a straight line, and is accom-


STICK RIGHT AND SLIGHTLY FORWARD LEFT PEDAL
CONTROLS NEUTRAL
CONTROLS NEUTRAL
STICK RIGHT AND SLIGHTLY FORWARD RIGHT PEDAL
STICK RIGHT AND SLIGHTLY FORWARD

SLOW ROLL

plished by use of ailerons. The rudder and elevator are used only to keep the plane headed straight.



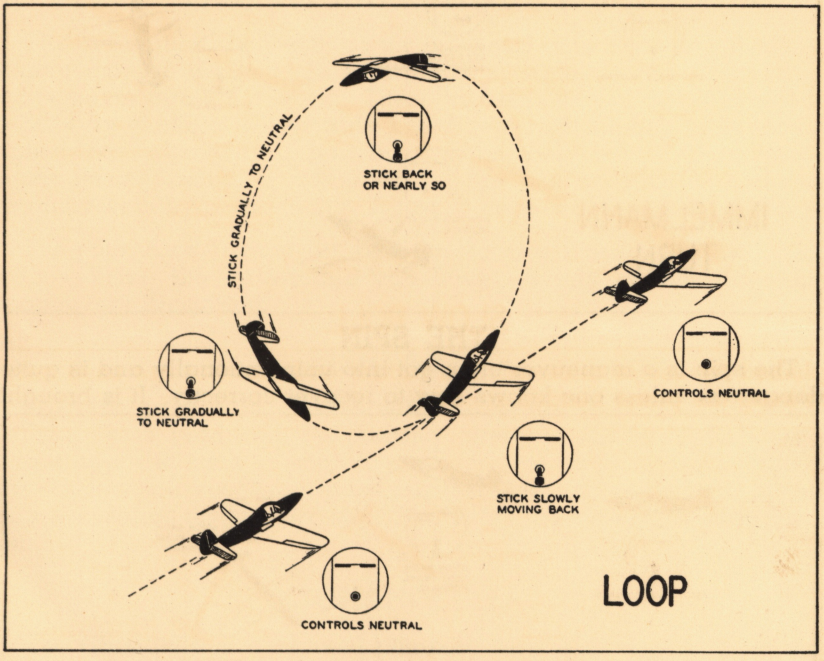
WINGOVER

THE WINGOVER

A wingover is executed in the following manner. Put the plane into a steep climb by gradually pulling back on the stick. Make a turn using the rudder (and sometimes slight ailerons) until the plane is pointed down. Then level out by gradually pulling back on the stick.

THE LOOP

Probably the best known maneuver is the loop. Before making the loop, excess speed must be gained by a slight dive or by giving the motor full throttle. The control stick is then slowly and gradually pulled back until the top of the loop where the stick is all the way



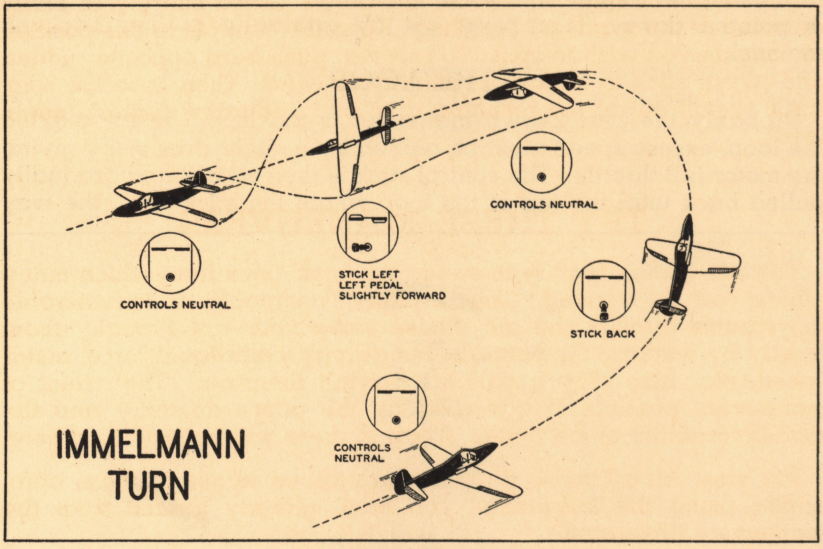
back or nearly so. Then, to prevent the plane from snapping out, the stick is gradually returned to neutral as you come out of the loop. The ailerons and rudder are not used except to keep the plane in line.

An outside loop is made by pushing the stick forward and holding it until the loop is completed. This is hard on the plane due to the negative load imposed on the wings.

THE IMMELMANN TURN

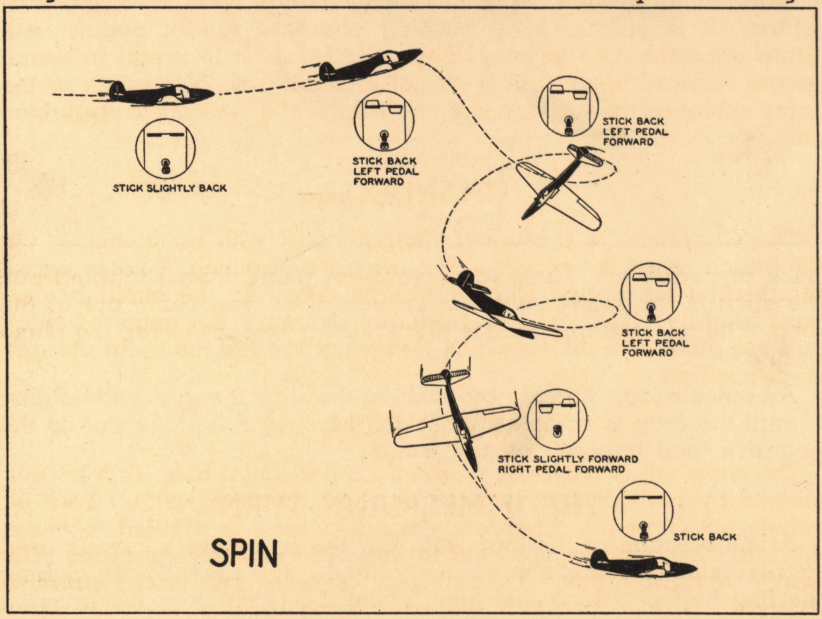
A combination of the loop and roll, the Immelmann turn is used for reversing direction and gaining altitude. It is executed by making the first half of a loop and then, while the plane is in the inverted

position, doing a half roll so the plane is right side up. Pull the stick back gradually until you are upside down. Then neutralize the stick and push it to one side to roll out. Use rudder as in last half of slow roll.



THE SPIN

The spin is a maneuver often got into unintentionally and is quite dangerous unless one knows how to recover correctly. It is brought



on by a stall. A plane can be put into a stall by slowly pulling back on the stick until the plane loses flying speed and falls off into a spin. Most training planes will not spin as the result of a stall, so if you desire to spin, the rudder should be turned sharply in either direction at the moment of stalling. Keep the controls in this position as long as you wish to spin. To recover, push hard opposite rudder, and return stick to neutral or slightly forward. Then ease the stick back to pull out of the resulting dive and neutralize controls when level.

* * *

TRY THESE MANEUVERS

The aerobatics dealt with so far are basic ones from which many others can be derived. The airplane is capable of innumerable movements through the air. These movements are brought about mostly by working the controls, but gravity, centrifugal force, motor speed, etc., also play a part in carrying them out. The extent of maneuvers possible is governed by the pilot's dexterity and the maneuverability of the plane. A few of these will be described here.

Put your Air-o-Trainer through the various stages of these aerobatics, using the knowledge you have already gained from the maneuvers illustrated.

FISHTAILING

Skidding from side to side with the wings level is called fishtailing. It is produced by pushing alternate rudder pedals with slight opposite stick to keep the wings level. It is useful in losing excess forward speed but does not increase rate of descent to the same extent as the forward slip. Neutralize the controls to straighten out.

CHANDELLE

The Chandelle is a banked climbing turn with a pull-out at the top which faces the plane in the opposite direction. Excess speed should first be gained with a shallow dive. As the climb begins, bank slightly. Near the top gradually decrease the angle of climb and use ailerons until the plane flattens out at the top in an upright, level position.

SNAP ROLL

The snap roll is basically a spin on a horizontal axis. It is accomplished by pulling sharply back on the stick and pushing hard on either rudder pedal. Frequently some aileron is applied to assist the roll. The controls are held in this position until the plane rolls nearly upright again. To pull out, reverse and then neutralize controls.

SPLIT-S TURN

The split-S turn might be called a reverse Immelmann. It is begun with a climb and half roll which turns the plane upside down, then a dive and pull-out with the plane heading in the opposite direction.

FALLING LEAF

The falling leaf is a series of alternate sideslips made with the airplane in stalled position. Idle the motor and slowly pull back a little on the stick. As the plane stalls pull the stick all the way back and push hard on either pedal. This will start the plane into a spin. As soon as it starts slipping to the side, push hard opposite rudder, keeping the stick back. The nose and low wing will slowly lift and the plane will start to fall off into an opposite spin and the controls are immediately reversed, etc. Recover normal flight by pushing forward on the stick and then neutralizing the controls.

STEEP TURN

The controls are used quite differently in a steep turn in comparison to shallow turn. More power is required than for normal cruising. The plane is put into a steep turn in the same manner as for a shallow turn by banking and turning the rudder simultaneously, but the bank is gradually increased until the turn is as steep as required. The bank should not be beyond 70 degrees as loss of speed and subsequent stalling may result. As the bank increases, the rudder is gradually straightened and the stick pulled back since the elevators are now helping to keep the plane in the turn and the rudder will have to be used in place of the elevators to control horizontal attitude.

SPIRAL TURN

The spiral is merely a gliding turn continued for several circles. It is a good way to lose altitude over some determined objective and is very useful in making spot landings.

* * *

YOUR FUTURE IN FLYING

Once you have gained an understanding of what makes an airplane fly and how it is controlled in the air through the use of your Air-o-Trainer, your mastery of its operation becomes a great deal easier. Practise the maneuvers described until you can do them smoothly and without hesitation.

The material in this booklet is an approach in theory toward the operation of controls in an airplane. Flying an airplane calls for coordination of many movements and cannot be done by fixed rules. Your instructor will discuss with you the variations and different ways of doing maneuvers.

There are quite a few good books on aeronautics available. Reading these and practicing flight maneuvers on your Air-o-Trainer will give you a good background for your actual flight instruction.

Requirements for
STUDENT PILOT CERTIFICATE

The requirements listed below have been set up by the Civil Aeronautics Authority, Dept. of Commerce, Washington, D. C., to govern civilian student flying in the United States. They are printed here in the interests of those who may wish to become student pilots.

AGE

Applicant shall be at least 16 years of age. If applicant be less than 21 years of age at the time of making application, he shall submit with his application the written consent of either parent, or legal or natural guardian to the issuance of the pilot certificate sought.

CHARACTER

Applicant shall be of good moral character.

CITIZENSHIP

Applicant may be of any nationality.

EDUCATION

If an applicant is unable to read, speak, and understand the English language, appropriate operation limitations may be entered upon his student pilot certificate.

PHYSICAL CONDITION

Applicant shall comply with the following requirements as to physical condition, demonstrated by examinations:

Eye: Applicant shall have: (1) a visual acuity of at least 20/50 in each eye separately, without correction. If the vision in either or both eyes is poorer than 20/50 and is brought up 20/30 or better in each such eye by glasses, the applicant may be qualified on condition that such glasses be worn while piloting aircraft; (2) an average of 30 millimeters or less on the depth perception apparatus, with or without glasses. If the depth perception is greater than 30 millimeters without correction and can be corrected to at least 30 millimeters by glasses, the applicant may be qualified upon condition that such glasses be worn while piloting aircraft; (3) no diplopia unless corrected by glasses, in which case such glasses shall be worn, while piloting aircraft; and (4) no serious pathology of the eye.

Ear, nose, throat, and equilibrium: Applicant shall be able to hear the whispered voice at 3 feet; shall have no acute or chronic disease of the internal ear, no disease or malformation of the nose or throat which may interfere with or be aggravated by flying, and no disturbance in equilibrium.

General physical condition: Applicant shall have no organic or functional disease or structural defect or limitation which would interfere with the safe piloting of aircraft.

Nervous system: Applicant shall have no disease of the mental or nervous system and no abnormality of the personality.

Exceptions to physical requirements: An applicant may receive a certificate in spite of a failure to comply with the above physical requirements, if his physical deficiency is such as not to interfere with his safe piloting of aircraft. Any applicant receiving a certificate under these conditions may be restricted to particular types of operation or types of aircraft.

AERONAUTICAL KNOWLEDGE

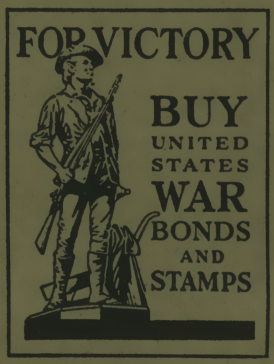
No requirement is prescribed but, prior to his first solo flight, applicant shall demonstrate thorough familiarity with the provisions of Part 60 of the Civil Air Regulations dealing with contact flight by satisfactorily accomplishing a written examination on such provisions, and such fact shall be certified to by his instructor.

AERONAUTICAL EXPERIENCE

No requirement.

AERONAUTICAL SKILL

No requirement is prescribed but, prior to his first solo flight, applicant shall have had 8 hours dual flight instruction, including recovery from spins and stalls and shall have been deemed, in the opinion of his instructor, competent to make such flights. Such competency shall be certified to by his instructor on his student pilot certificate. Dual flight instruction in recovery from spins shall not be required when an applicant has received all of his dual flight instruction in aircraft fully determined to be characteristically incapable of spinning. Until he has received dual instruction in spins any such applicant shall be limited to the operation of aircraft possessing that characteristic and the instructor shall make a notation to that effect on his pilot certificate. When the applicant has received dual instruction in spins the instructor shall make a notation to that effect on the certificate. Prior to his first cross-country, solo flight, applicant shall have logged 8 hours solo flight time and his instructor shall have certified on the student pilot certificate that he deems the student competent to make such flight. The dates of such solo flights and the type and, in the case of an airplane, the airplane class and horsepower range of the aircraft so flown shall also be certified to by the instructor.



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